

### **REMARKS**

Claims 2-11 and 14-47 are now pending in the application. Claims 19, 24 and 31-45 are withdrawn. Presently Claims 2-11, 14-18, 20-23, 25-30, 46 and 47 are rejected on the basis of new art and new grounds of rejection. The previous indication of allowability of Claims 13, 15, 20-28 and 30 is withdrawn in view of new references. It is noted that in view of the withdrawal of the allowability of generic Claim 20 that Claim 24 is withdrawn from further consideration. It appears that this same situation exists with respect to Claim 19. That is, if Claim 2 is found to be allowable it is respectfully requested that Claim 19 be allowed as well. If Claim 20 is found allowable, Claim 24 be should be allowed as well. The Examiner is respectfully requested to reconsider and withdraw the rejections in view of the amendments and remarks contained herein.

### **REJECTION UNDER 35 U.S.C. § 112**

Claims 2-11, 14-18, 20-23, 25-30 and 46-47 stand rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point and distinctly claim the subject matter which Applicant regards as the invention. This rejection is respectfully traversed.

The basis of the rejection is applied to both independent Claims 20 and 46. However, the stated reason for rejection quotes the passage from Claim 20 which does not appear in Claim 46. There is no corresponding recitation and arrangement of elements in Claim 46. Thus, the rejection does not apply to Claim 46.

The rejection is not supported as to Claim 20 at least for the following reason. The specification at page 10 lines 11-21 states as follows:

At this point, one of two things may happen, depending on the exact nature of the system. If a low temperature CO adsorbent is added into or before water gas shift reactor 2 as described below, the CO in the cold reformat will adsorb on the adsorbent in water gas shift reactor 2. As water gas shift reactor 2 comes up to its operating temperature, the CO will desorb from the CO adsorbent and will be shifted to CO<sub>2</sub> on the water gas shift catalyst(s). At that point, normal operation will commence. If there is no CO adsorbent either inside or before water gas shift reactor 2, or there is not enough adsorbent to adsorb all of the CO in reformat stream 18, then the CO will pass through water gas shift reactor 2 and continue via streams 19 and 20 into adsorber 3. The remaining CO in stream 20 will adsorb in the high-pressure section of adsorber 3.

From the aforesaid passage it can be seen that the specification encompasses a number of alternative embodiments including, but not limited to, making and operating a system wherein, for example, the adsorbent zone is located downstream from the water gas shift zone.

## **THE INVENTION**

Before addressing specific rejections, it is useful to understand key features of the present invention as claimed, which are lacking in the art.

It should be understood that the invention for the first time addresses a system configuration and method of operation which provides the ability to reduce carbon monoxide content in a startup condition and during normal operation of a fuel processor's system. At the same time, the use of a preferential oxidizer reactor to accomplish CO reduction is not needed.

This important new feature is particularly seen in the description of the invention on pages 9 and 10 at the bottom of page 9 to the middle of page 10 describing that: at

startup, the system has the ability to adsorb CO when the primary reactor is producing a product stream but when the water gas shift reactor is below its operating temperature.

In addition, none of the references show the use of an adsorbent in a reactor along with a water gas shift reaction catalyst together. This specific new feature makes it possible to actually create more hydrogen and to further reduce the concentration of carbon monoxide according to the reaction:  $\text{H}_2\text{O} + \text{CO} \rightarrow \text{H}_2 + \text{CO}_2$ .

The Office Action's statement that the references of record do not disclose the features of independent Claim 46 are correct because the art of record did not recognize that a fuel processor system on startup contains water gas shift reactor which is not at temperature. In order to supply a product to the fuel cell itself, essentially instantaneously, such as in a vehicle, it is necessary to have an adsorbent present along with a water gas shift catalyst (which catalyst is not yet up to temperature to perform its function).

Further, none of the art of record was concerned with overall system efficiency to minimize fuel consumption such as in the case of a mobile unit fuel processor in a vehicle. In the present invention, the equilibrium to form additional hydrogen by the water gas shift reaction in the presence of an adsorbent removes carbon monoxide to improve efficiency and to actually encourage production of more hydrogen. Yet, rapid start-up is also possible.

One of the primary references that is relied on (namely, Meyer) does not have any relevance whatsoever to reforming a fuel to produce hydrogen.

The present system also prevents consequences of the reverse water gas shift reaction on start-up where CO is actually formed by reaction of  $\text{CO}_2$  with  $\text{H}_2$ . Thus, on

start up, the adsorbent removes CO while the catalyst bed is below temperature. Undesired reactions consuming precious H<sub>2</sub> are minimized by having the adsorbent present in the same reactor along with the water gas shift catalyst.

It is respectfully submitted that the basis of the Office Action that any type of reaction vessel may be combined with any other type of reaction vessel is unsupported and spurious. There is no teaching or suggestion in any of the art of record for a combination. There is no teaching or suggestion in any of the art of record of the important advantage of a system configuration and method of operation which is optimized for both a startup mode, when the water gas shift reactor is not up to temperature, and for a mode which minimizes consumption of the precious hydrogen product and further enhances hydrogen content than would be the case in separate vessels. Further, there is no suggestion to achieve heretofore unexpected operating efficiencies and low concentrations of carbon monoxide. These features are all accomplished while at the same time eliminating the need for a preferential oxidizer reactor.

**BELLOWS ET AL. (USPN 5,604,047)**

It is admitted in the Office Action that Bellows does not show first and second sequentially operated adsorbers. Bellows does not show or suggest combining water gas shift reactor and adsorbent. These are important features of the present invention captured in independent Claims 20 and 46. It is not understood how Claims 29 and 7, which respectively depend on Claim 20 and 46, are rejected on the basis of Bellows.

**MEYER (USPN 3,011,589)**

Meyer is applied as a reference in a number of rejections. However, Meyer is not relevant at all to the present invention.

Meyer shows a method where a crude refinery gas containing hydrogen is purified in a catalyst bed, a caustic scrubber and a molecular sieves to remove various components of the refinery crude gas stream which are undesirable. Meyer relies only on adsorption and extreme measures not at all adaptable to a fuel processor for a fuel cell, for example, a caustic scrubber. Meyer does not use a water gas shift because Meyer's gas stream does not have any water in it.

Meyer is not able to be combined with any of the art of record directed to reforming a fuel to make a hydrogen stream because Meyer's caustic scrub, among other things, would introduce undesirable components and because Meyer is scrubbing the stream which does not contain any water. Meyer is not combinable with any art of record which includes a water gas shift reactor.

In addition, Meyer's adsorbing conditions are extreme such as -285°F. See, for example, in contrast, Bellows discloses possibly adsorbing at a temperature in a range between 25°C to 500°C.

**HUFTON ET AL. ("SORPTION ENHANCED REACTION PROCESS FOR HYDROGEN PRODUCTION")**

Hufton is relied upon in the rejection. Hufton shows a shows a conventional steam reforming process (Figure 1) for hydrogen production which includes a steam reforming reactor followed by a water gas shift reactor followed by a pressure steam

adsorber. There is no suggestion in Hufton to combine a water gas shift reactor and an adsorber together. Further, Hufton teaches that the conventional system of Figure 1 is undesirable. It is Figure 1 that the rejection relies upon.

Hufton (Figure 9) suggests that the original reformer reactor itself includes a carbon monoxide adsorber. This is completely contrary to the present invention and contrary to Figure 1 of Hufton.

In the present invention, a first steam reforming reactor is present to optimize the conversion of a hydrocarbon fuel to a hydrogen rich stream. Thereafter, optimum pressure and temperature conditions and catalysts are provided in a water gas shift reactor for the purpose of creating more hydrogen and preferably at the same time including an adsorbent in the water gas shift reactor which further fosters the production of hydrogen and minimizes undesired reactions, particularly on start-up.

**SMITH ET AL. (USPN 3,699,218)**

Smith shows a hydrogen manufacturing system which has components similar to Hufton Figure 1, which Hufton defines as being an undesirable system, including in sequence: a hydrogen generation zone, a shift zone, and two adsorbent zones. There is no suggestion in Smith to combine the water gas shift reactor and adsorber functions together.

**KRISHNAMURTHY (USPN 5,096,470)**

Note that Krishnamurthy reference is cited only for the pressure swing adsorber and does not address how the hydrogen/carbon monoxide stream is produced in the first place.

**KEEFER ET AL. (WO 00/016425)**

Keefer shows a system similar to Figure 1 of Hufton. Note that Hufton teaches away from its Figure 1 configuration and teaches instead a new system as in Hufton Figure 9. Hufton Figure 9 lacks the components of Keefer. Therefore Keefer and Hufton are not combinable.

**REJECTION UNDER 35 U.S.C. § 103**

Claims 46, 7 and 29 are rejected under Bellows. See earlier comments regarding deficiencies of Bellows.

Claim 14 is rejected on Bellows and Hufton. Bellows and Hufton cannot be combined. Hufton teaches the combination of steam reformer and adsorber and with no water gas shift reactor. Bellows shows a steam reformer and a separate water gas shift reactor.

Claims 46-47, 2-3, 8 and 14-15 are rejected on the basis of Hufton and Meyer. For the reasons described earlier, Meyer does not teach a system for production of hydrogen. Rather, Meyer teaches a system for scrubbing a refinery crude gas stream which contains hydrogen, which includes methods of cleaning such as caustic stream cleanup which are not usable in a fuel cell system. Further, Meyer is not in any way

combinable with a system that includes a water gas shift reactor, because Meyer's system for cleaning a refinery crude gas applies to a gas which does not contain any water. Thus, Meyer is not able to be combined with a system that includes a water gas shift reactor.

Claims 4-7, 16-18 and 29 are rejected on the basis of Hufton in view of Meyer and Keefer. For the reasons described immediately above, Hufton and Meyer are not combinable. Keefer does not supply the deficiencies of Hufton or Meyer. Further, Hufton teaches away from its Figure 1 configuration and teaches instead a new system, Figure 9, which lacks the components of Keefer. Keefer and Hufton are not combinable.

Claims 9-11 are rejected on the basis of Hufton, Meyer and Kirshnamurthy. Hufton and Meyer are not combinable for the reasons given above. Kirshnamurthy does not supply the deficiencies of Hufton and Meyer. Kirshnamurthy is cited only for a pressure swing adsorber and cannot supply the deficiencies of Hufton and Meyer as to how the original hydrogen containing stream is obtained as in the process of the present invention.

Claims 20-23, 25-26 and 30 are rejected on the basis of Hufton in view of Meyer and Keefer. Hufton and Meyer are not combinable for the reasons earlier hereinabove and Keefer does not supply the deficiencies of Hufton and Meyer for the reason describer earlier above.

Claims 27-28 are rejected on the basis of Hufton, Meyer, Keefer and Kirshnamurthy. Hufton and Meyer are not combinable for the reasons given earlier

above, Keefer and Kirshnamurthy do not supply the deficiencies of Hufton and Meyer for the reasons given earlier above.

Claims 46-47, 2-8, 14-17 and 29 are rejected on the basis of Keefer and Meyer. Keefer and Meyer are not combinable for reasons similar with respect to the non-combinable systems of Meyer and Hufton Figures 1 or 9. Keefer shows system elements similar to Hufton's undesirable Figure 1. Thus, Meyer and Keefer are not combinable for the reasons given above.

Claims 9-11 are rejected on the basis of Keefer, Meyer and Kirshnamurthy. Keefer and Meyer are not combinable for reasons similar with respect to the non-combinable systems of Meyer and Hufton Figures 1 or 9. Keefer shows system elements similar to Hufton's undesirable Figure 1. Thus, Meyer and Keefer are not combinable for the reasons given above. Kirshnamurthy only shows an adsorber and does not supply the deficiencies of Keefer and Meyer.

Claim 18 is rejected on the basis of Keefer and Meyer. Keefer and Meyer are not combinable for reasons similar with respect to the non-combinable systems of Meyer and Hufton Figures 1 or 9. Keefer shows system elements similar to Hufton's undesirable Figure 1. Thus, Meyer and Keefer are not combinable for the reasons given above.

Claims 20-23, 25-26 and 30 are rejected on the basis of Keefer and Meyer. Keefer and Meyer are not combinable for reasons similar with respect to the non-combinable systems of Meyer and Hufton Figures 1 or 9. Keefer shows system elements similar to Hufton's undesirable Figure 1. Thus, Meyer and Keefer are not combinable for the reasons given above.

Claims 27 and 28 are rejected this being unpatenable over Keefer, Meyer and Kirshnamurthy. Keefer and Meyer are not combinable for reasons similar with respect to the non-combinable systems of Meyer and Hufton Figures 1 or 9. Keefer shows system elements similar to Hufton's undesirable Figure 1. Thus, Meyer and Keefer are not combinable for the reasons given above. Kirshnamurthy only shows an adsorber and does not supply the deficiencies of Keefer and Meyer.

#### **DOUBLE PATENTING**

Claims 2-11, 14-18, 20-23, 25-30 and 46-47 are rejected under the judicially created doctrine of obviousness-type double patenting in respect of USPN 6,692,545 combined with Meyer and Kirshnamurthy.

The Examiner's attention is respectfully directed to independent Claims 1 and 21 of USPN 6,692,545. Each of independent Claims 1 and 21 define the system which includes an apparatus for removing carbon monoxide using an adsorbent which adsorbs carbon dioxide. The system of the '545 patent is a completely different system and method for providing a hydrogen rich stream and minimizing presence of carbon monoxide.

The system of the '545 patent contains an adsorbent for adsorbing carbon dioxide so as to shift the equilibrium toward carbon monoxide consumption. That is, the '545 patent removes carbon dioxide as it is produced therefore encouraging further reaction of carbon monoxide with water. This feature is not recited in the independent claims of the present application 09/780,184. To the contrary, independent Claims 20

and 46 of the present invention each recite "adsorbent adapted to adsorb the carbon monoxide".

It is evident that the present application and the issued patent approach the complex problem of reducing carbon monoxide content and enriching hydrogen content in different ways and with different materials and systems.

Neither Meyer nor Kirshnamurthy supply the deficiency of the '545 patent. It is respectfully requested that this double patenting rejection be withdrawn.

### **CONCLUSION**

It is believed that all of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. Applicant therefore respectfully requests that the Examiner reconsider and withdraw all presently outstanding rejections. It is believed that a full and complete response has been made to the outstanding Office Action, and as such, the present application is in condition for allowance. Thus, prompt and favorable consideration of this amendment is respectfully requested. If the Examiner believes that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at (248) 641-1600.

Respectfully submitted,

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By:   
Linda M. Deschere, Reg. No. 34,811

HARNESS, DICKEY & PIERCE, P.L.C.  
P.O. Box 828  
Bloomfield Hills, Michigan 48303  
(248) 641-1600

LDES/srh